We claim:

1. Microchannel apparatus, comprising:
a first channel extending in a first direction;
a second channel extending in a second direction; and
a third channel extending in the second direction;
a fourth channel extending in the second direction; and
a fifth channel extending in the second direction;
wherein the first and second directions are substantially coplanar;
wherein the second and third channels are adjacent and parallel;
wherein the first channel is not parallel to either the second or third channels;
wherein the first channel is connected to the second channel and the third channels via a first gate;
wherein the third channel is positioned farther in the first direction than the second channel;
wherein the third channel comprises a microchannel;
wherein the second channel comprises a microchannel;
wherein the second channel has an opening with a first cross-sectional area and the third channel has an opening with a second cross-sectional area;
wherein the first gate has a cross-sectional area that is smaller than the sum of first and second cross-sectional areas and the wall cross-sectional area between them;
wherein the fourth and fifth channels are adjacent and parallel;
wherein the first channel is connected to the fourth channel and the fifth channels via a second gate;
wherein the fourth and fifth channels are positioned farther in the first direction than the third channel;
wherein the fourth channel comprises a microchannel;
wherein the fifth channel comprises a microchannel;
wherein the fourth channel has an opening with a third cross-sectional area and the fifth channel has an opening with a fourth cross-sectional area;
wherein the second gate has a cross-sectional area that is smaller than the sum of third and fourth cross-sectional areas and the wall cross-sectional area between them; and
wherein the cross-sectional area of the first gate differs from that of the cross-sectional area of the second gate.

2. The microchannel apparatus of claim 1 wherein the first gate has a cross-sectional area between 2-98% of the combined cross-sectional areas of the connecting microchannels served by the first gate.

3. The microchannel apparatus of claim 1 wherein the apparatus is a laminate and the first gate comprises a sheet with a cross-bar.

4. A laminated device, comprising:

a first layer comprising microchannels that end in a first crossbar; and

a second layer comprising microchannels that end in a second crossbar;

wherein the first crossbar defines at least a portion of one edge of an M2M manifold;

wherein the second crossbar projects into the M2M manifold;

wherein an interface between the microchannels in the second layer and the manifold is formed by an open gap between the first and second crossbars.

5. The laminated device of claim 4 wherein the first layer is adjacent to the second layer..

6. The laminated device of claim 5 wherein microchannels in first and second layers are aligned.

7. The laminated device of claim 5 wherein the device is made by a process wherein each layer is a sheet and the sheets are stacked.

8. The laminated device of claim 4 further comprising:

a second set of microchannels in the first layer that end in a third crossbar; and

a second set of microchannels in the second layer that end in a fourth crossbar;

wherein the third crossbar defines at least a portion of one edge of the M2M manifold;

wherein the fourth crossbar projects into the M2M manifold;

wherein a second interface between the microchannels in the fourth layer and the manifold is formed by an open gap between the third and fourth crossbars;

wherein the open gap between the third and fourth crossbars is smaller than the open gap between the first and second crossbars

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9. A system comprising a macromanifold connected to at least two of the laminated devices of claim 4.

10. A method of distributing flow from a manifold through a connecting channel matrix, comprising:

passing a fluid through a manifold inlet and into a manifold having the following characteristics:

the height of the manifold (h_{m2m}) is 2mm or less;

the length of the manifold (L_{m2m}) is 7.5 cm or greater;

the length of an optional straightening channel portion (L_2) divided by L_{m2m} is less than 6;

passing the fluid into the manifold with a momentum (Mo) of at least 0.05

maintaining the DPR_2 ratio at 2 or greater or maintaining a DPR_3 ratio of 0.9 or less; and

distributing the fluid from the manifold into at least 2 channels which are connected to the manifold, with a quality index factor as a function of connecting channel areas of equal to or less than *Q(Ra)*, where:

$$Q(Ra) = 0.0008135Ra^6 - 0.03114Ra^5 + 0.4519Ra^4 - 3.12Ra^3 + 11.22Ra^2 - 23.9Ra + 39.09$$

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11. The method of claim 10 wherein R_a is equal to or less than 12.

12. The method of claim 10 wherein R_a is equal to or less than 3.

13. The method of claim 11 wherein the fluid flow rate through the manifold is maintained such that the quantity $\{|0.058 + 0.0023(\ln Re)^2(D)| / L_{M2M}\}$ is less than 0.01, where Re is Reynolds number.

14. The method of claim 11 wherein FA is less than 0.01

15. A method of distributing flow from a manifold through a connecting channel matrix, comprising:

passing a fluid into a manifold having the following characteristics:

the height of the manifold is 2mm or less;

the length of an optional straightening channel portion (L_2) divided by L_{M2M} is less than 6;

with a FA value of less than 0.01

$$FA = \frac{\left[0.058 + 0.0023(\ln \mathrm{Re})^2\right]^2 D}{L_{M2M}} < 0.01$$

maintaining the DPR_2 ratio at 2 or greater or maintaining a DPR_3 ratio of 0.9 or less; and

distributing the fluid from the manifold into at least 2 channels, which are connected to the manifold, with a quality index factor as a function of connecting channel areas of Q_2 equal to or less than 85% of the Q_c function of connecting channel area ratio Ra and DPR_1 of

$$Q_c\left(Ra, DPR_1\right) = \mathrm{E1+E2+E4+E6+E8+E10+E12},$$

where

$$\mathrm{E1} = \frac{112.9+1.261\mathrm{DPR}_1}{1+0.3078\mathrm{DPR}_1+0.003535\mathrm{DPR}_1^2}\left[\frac{(\mathrm{Ra}-2)(\mathrm{Ra}-4)(\mathrm{Ra}-6)(\mathrm{Ra}-8)(\mathrm{Ra}-10)(\mathrm{Ra}-12)}{(1-2)(1-4)(1-6)(1-8)(1-10)(1-12)}\right]$$

$$\mathrm{E2} = \frac{91.73-1.571\mathrm{DPR}_1+0.01701\mathrm{DPR}_1^2}{1+0.2038\mathrm{DPR}_1+0.00193\mathrm{DPR}_1^2}\left[\frac{(\mathrm{Ra}-1)(\mathrm{Ra}-4)(\mathrm{Ra}-6)(\mathrm{Ra}-8)(\mathrm{Ra}-10)(\mathrm{Ra}-12)}{(2-1)(2-4)(2-6)(2-8)(2-10)(2-12)}\right]$$

$$\mathrm{E4} = \frac{24.27-4.943\mathrm{DPR}_1+0.3982\mathrm{DPR}_1^2}{1-0.2395\mathrm{DPR}_1+0.03442\mathrm{DPR}_1^2-0.000006657\mathrm{DPR}_1^3}\left[\frac{(\mathrm{Ra}-1)(\mathrm{Ra}-2)(\mathrm{Ra}-6)(\mathrm{Ra}-8)(\mathrm{Ra}-10)(\mathrm{Ra}-12)}{(4-1)(4-2)(4-6)(4-8)(4-10)(4-12)}\right]$$

$$\mathrm{E6} = \frac{29.23-2.731\mathrm{DPR}_1+0.09734\mathrm{DPR}_1^2}{1-0.1124\mathrm{DPR}_1+0.005045\mathrm{DPR}_1^2}\left[\frac{(\mathrm{Ra}-1)(\mathrm{Ra}-2)(\mathrm{Ra}-4)(\mathrm{Ra}-8)(\mathrm{Ra}-10)(\mathrm{Ra}-12)}{(6-1)(6-2)(6-4)(6-8)(6-10)(6-12)}\right]$$

$$\mathrm{E8} = \frac{25.98+11.26\mathrm{DPR}_1+0.02201\mathrm{DPR}_1^2+0.5231\mathrm{DPR}_1^3}{1-0.8557\mathrm{DPR}_1+0.00887\mathrm{DPR}_1^2+0.02049\mathrm{DPR}_1^3-0.000002866\mathrm{DPR}_1^4} \times\left[\frac{(\mathrm{Ra}-1)(\mathrm{Ra}-2)(\mathrm{Ra}-4)(\mathrm{Ra}-6)(\mathrm{Ra}-10)(\mathrm{Ra}-12)}{(8-1)(8-2)(8-4)(8-6)(8-10)(8-12)}\right]$$

$$E10=\frac{20.75-3.371DPR_1+0.9026DPR_1^2+0.01277DPR_1^3}{1-0.1514DPR_1+0.03173DPR_1^2+0.0003673DPR_1^3}\left[\frac{(Ra-1)(Ra-2)(Ra-4)(Ra-6)(Ra-8)(Ra}{(10-1)(10-2)(10-4)(10-6)(10-8)(10-}\right.$$

$$E12=\frac{51.67+18.94DPR_1+21.57DPR_1^2+21.57DPR_1^3}{1+1.183DPR_1+0.5513DPR_1^2-0.00004359DPR_1^3}\left[\frac{(Ra-1)(Ra-2)(Ra-4)(Ra-6)(Ra-8)(Ra-10)}{(12-1)(12-2)(12-4)(12-6)(12-8)(12-10)}\right]$$

where Ra ranges from 1 to 12, and DPR_1 is greater than 0 and less than 300.

16. The method of claim 15 wherein:

$Q_2 \leq 18\%$ if $DPR_1 < 1$;

$Q_2 \leq 16.5\%$ if $1 \leq DPR_1 < 3$;

$Q_2 \leq 15\%$ if $3 \leq DPR_1 < 5$;

$Q_2 \leq 10\%$ if $5 \leq DPR_1 < 10$;

$Q_2 \leq 7\%$ if $10 \leq DPR_1 < 15$;

$Q_2 \leq 6\%$ if $15 \leq DPR_1 < 20$;

$Q_2 \leq 4\%$ if $20 \leq DPR_1 < 30$;

$Q_2 \leq 3\%$ if $30 \leq DPR_1 < 50$;

$Q_2 \leq 2\%$ if $50 \leq DPR_1 < 100$; and

$Q_2 \leq 1\%$ if $100 \leq DPR_1 < 200$.

17. The method of claim 15 wherein the fluid is passed into the manifold with a momentum (Mo) of at least 0.05.

18. A method of distributing flow from a manifold through a connecting channel matrix, comprising:

passing a fluid through a manifold and into a connecting channel matrix,

wherein the connecting channel matrix comprises repeating units of microchannels of differing cross-sectional areas, and wherein the manifold has an inlet disposed on one side of the connecting channel matrix so that fluid flow through the manifold is at a nonzero angle to flow in the connecting channel matrix;

wherein the connecting channels in two or more repeating units do not change in cross-sectional area in the direction of length through the manifold; and wherein a fluid flows into the manifold with a momentum (Mo) of at least 0.05; and is distributed through the connecting channel matrix with a Q_2 of less than 30%.

19. The method of claim 18 wherein Q_2 is less than 25%.

20. The method of claim 18 wherein Q_2 is less than 10%.

21. A method of distributing flow from a manifold through a connecting channel matrix, comprising:

passing a fluid through a manifold inlet and into a manifold such that the fluid passes through a first portion of a manifold in a first flow regime and passes through a second portion of a manifold in a second flow regime

wherein the manifold manifold has the following characteristics:

the height of the manifold (h_{m2m}) is 2mm or less;

the length of an optional straightening channel portion (L_2) divided by L_{m2m} is less than 6;

maintaining the DPR_2 ratio at 2 or greater or maintaining a DPR_3 ratio of 0.9 or less; and

distributing the fluid from the manifold into at least 2 channels, which are connected to the manifold, with a quality index factor as a function of connecting channel areas of equal to or less than *Q(Ra),* where

$$Q(Ra) = 0.0008135Ra^6 - 0.03114Ra^5 + 0.4519Ra^4 - 3.12Ra^3 + 11.22Ra^2 - 23.9Ra + 39.09$$

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22. The method of claim 21 wherein the first flow regime is turbulent and second flow regime is transitional.

23. The method of claim 22 wherein R_a is equal to or less than 12.

24. The method of claim 23 further comprising passing the fluid through a macromanifold that is connected to the manifold inlet.

25. A method of passing a fluid through a manifold of a microchannel device, comprising:

flowing a first fluid stream into a manifold and then through a first channel in a first direction;

flowing a portion of the first fluid stream to a second channel; and

flowing a portion of the first fluid stream through the second channel;
wherein the second channel extends at a nonzero angle relative to the first direction;
wherein the second channel comprises a microchannel and comprises at least one dividing wall that separates the second channel into at least a first and a second subchannel;
wherein the first layer and the manifold are each substantially planar; wherein the manifold is substantially contained within the first layer, and wherein the first layer and the manifold are substantially coplanar, and wherein the first channel is disposed in the first layer and flow through the first channel is substantially parallel to the plane of the first layer;
wherein the first channel and the manifold are about the same height;
wherein the second layer is substantially planar, and wherein the second channel is disposed in the second layer and flow through the second channel is substantially parallel to the plane of the second layer; and
wherein the first layer and the second layer are substantially parallel and the nonzero angle refers to an angle within the second layer.

26. The method of claim 25 wherein the second layer is adjacent to the first layer and the only flow into the second layer is from the first layer.

26. The method of claim 25 wherein a plate comprising an opening is disposed between the first and second layers and flow from the first layer passes through the opening into the second layer.

27. The method of claim 26 wherein the first layer comprises multiple adjacent parallel microchannels separated by channel walls; and
wherein the second layer comprises multiple adjacent parallel microchannels separated by continuous channel walls wherein the continuous channel walls traverse the width of the multiple adjacent parallel microchannels in the first layer.

28. The method of claim 26 wherein the second layer is made from a sheet containing slots.

29. The method of claim 26 wherein the first layer comprises multiple adjacent parallel microchannels separated by channel walls; and
wherein the second layer comprises multiple adjacent parallel microchannels separated by continuous channel walls;
wherein a portion of the flow through the first layer passes into the second layer where it is redistributed into the microchannels in the first layer.

30. The method of claim 29 wherein the presence of the second layer tends to equalize flow through the multiple adjacent parallel microchannels in the first layer.

31. The method of claim 29 wherein the multiple adjacent parallel microchannels comprise a crossbar that forces flow into the second layer; and

wherein, other than contact with the first layer, the second layer does not have any inlets or outlets.